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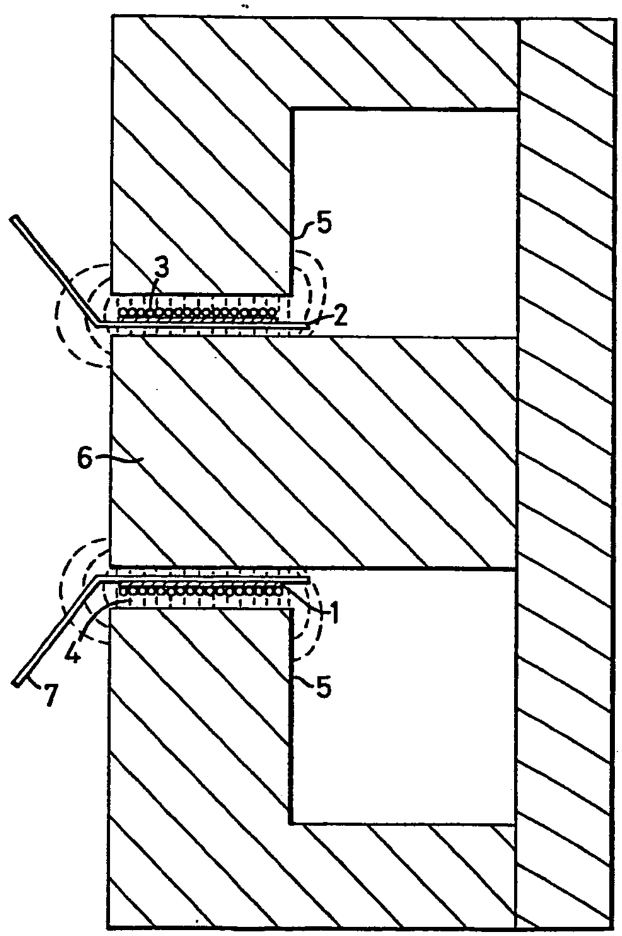
(56) Documents cited

GB	1276013	GB	0447846
GB	1035995	GB	0409433
GB	0568682		

(58) Field of search
H4J

(54) **Moving coil loudspeakers**

(57) A speech coil 3 in a moving-coil type loudspeaker includes a layer of magnetisable material 1 such as plastics tape impregnated with ferric oxide. The tape is wound on to a former 2 and moves with the coil to provide magnetic damping to more accurately centre the coil and reduce overshoot of the coil in response to current peaks



The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.
The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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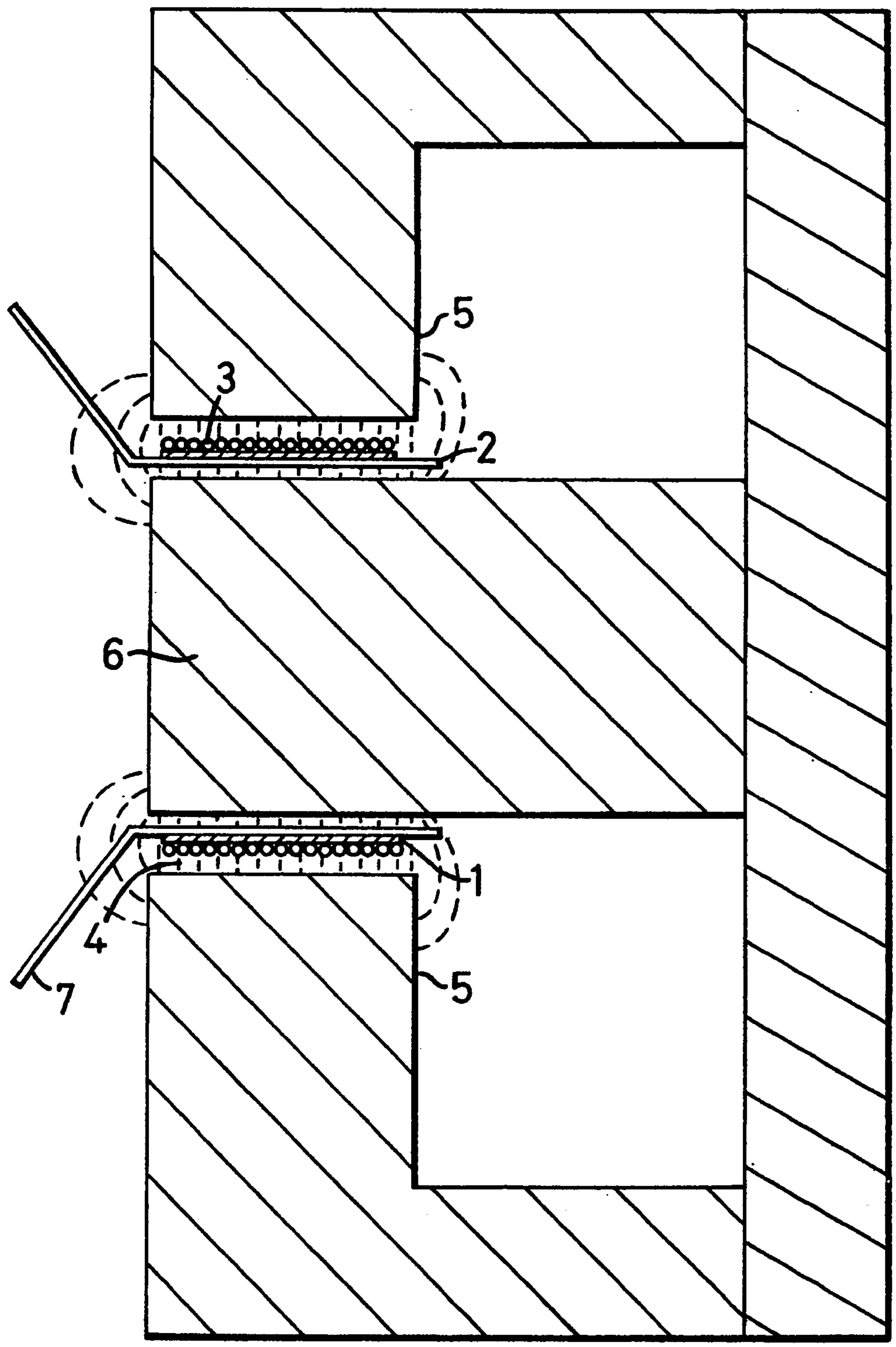

SPECIFICATION
Moving-coil loudspeakers

This invention relates to electrical to mechanical transducers of the moving coil type for use in loudspeakers in which the electrical coil drives the diaphragm of the loudspeaker.

In a loudspeaker, the force, in dynes, developed by the interaction of the current in the speech coil and the magnetic field is represented, by the equation:—

$$f = \int iBdl \qquad (1)$$

where B is the flux density, in gauss; taken over the whole length of the speech coil conductor (in centimeters), and
i is the current in amperes.

If the field is uniform over the whole length of the coil, equation (1) is simplified to

$$f = Bli \qquad (2)$$

The above equations express the fact that the force is equal to the product of flux density and length, averaged over the length of the coil, multiplied by the current.

In a loudspeaker designed for a specific purpose, such as to meet a specific market requirement, the available flux density provided by the permanent magnets is restricted by cost, and the resistance of the coil is defined. The designer then endeavours to obtain the maximum force with a given value of current. Within such constraints the average value of the term B.dl is required to be made as large as possible.

When low frequency sounds are reproduced the coil has to undergo relatively large excursions and these may involve movement from a region of one flux-density to one of another. This non-linearity causes distortion and in particular the inter-modulation distortion of the low frequencies upon high frequencies transmitted simultaneously or soon after.

If the coil is to respond to both high and low frequencies it is important to ensure that such excursions are controlled. However, it is difficult to mechanically damp this movement of the coil without seriously affecting the fidelity of the loudspeaker, and so many speakers suffer from pendulum type oscillations of the coil when the coil is subject to large currents. Apart from the fact that when oscillating in this manner the coil is not following the signal current, the pendulum oscillations may cause succeeding current pulses to be ineffective particularly when a complex frequency signal occurs. Unless these pendulum oscillations are reduced, modulation of the high order frequency content of the true signal by the lower frequencies of the same signal will occur.

If to improve linearity recourse is made to either a speech coil substantially longer than the air gap, or one that is shorter, then there is a loss of efficiency due respectively to the increased electrical resistance of the coil and the non-use of much of the available flux.

It is an object of this invention to provide an electrical to mechanical transducer for a loudspeaker of the moving coil type in which the pendulum oscillations are reduced and the movement of the coil more closely follows the dictates of the driving signal. This is achieved by increasing the flux density in the region of the coil.

According to the present invention there is provided an electrical to mechanical transducer for a loudspeaker of the moving-coil type including magentic pole pieces defining an air gap within which the coil is at least partially located, the coil including or having in moving association with it magnetisable material operative to interact with the magnetic field produced by the said pole pieces to damp movement of the coil, and wherein the coil and said magnetisable material are, at equilibrium, located within the axial extent of said air gap and such that the coil occupies substantially the full axial extent thereof. This enables the speech coil to have substantially the same axial length as the air gap so that a high frequency efficiency and low frequency fidelity can be obtained.

The magnetisable material may be plastics tape coated or impregnated with a magnetic composition such as ferric oxide, conveniently, this may be commercially available magentic recording tape.

By means of this magnetic damping the speech coil is maintained more accurately centred in the magnetic gap thereby providing a high average efficiency, and overshoot of the coil caused by a peak in the input current is restricted. The reproduction of speech and music by the loudspeaker is therefore more clearly defined.

Some loudspeakers include centring devices for holding the coils accurately in the middle of the air gap between the pole pieces, the present invention may obviate the need for such devices or at least may reduce the controlling force required for such devices.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawing which is a schematic axial section of part of a loudspeaker.

Referring to the Figure a moving coil loudspeaker includes a permanent magnet having an annular pole piece 5 and a central pole piece 6 of cylindrical shape extending co-axially through the annular pole piece to leave an annular gap 4. The distant end of the central pole piece has a flat surface which is co-planar with the corresponding surface of the annular pole-piece 5.

A loudspeaker cone 7 has a thin cylindrical neck 2 which acts as a former for a speech coil 3. The neck 2 of the cone extends co-axially around the pole piece 6 within the gap 4. The neck 2 has a lateral extent beyond the annular pole piece 5 on each end thereof. A layer of magnetic recording tape 1 is wound around the neck 2 of the cone such that it occupies an axial extent equal to the

axial extent of the air gap 4. The speech coil 3 is wound upon the magnetic tape 1 such that it too has an axial extent substantially equal to the extent of the air gap.

The lines of force of the magnetic field in the vicinity of the air gap are shown by dotted lines in the Figure and it will be seen that the magnetic field is uniform only in the region of the air gap 4 or just slightly beyond it.

The thickness of the magnetic recording tape 1 that is applied to the neck 2 of the cone is chosen so that the appropriate flux density is achieved. This may also be adjusted by selecting the type of magnetic tape from a range of commercially available types having magnetic permeabilities in a range of 800—8000 μ. A field strength of 24 K gauss can be obtained using standard permanent magnets and a single layer of magnetic tape. Other arrangementsd may be more appropriate to other types of coils such as those that are edge wound i.e. have no former. Other types of loudspeakers such as those with extremely low mass, thin film diaphragms require somewhat different application of the magnetisable material whether it is magnetic tape or some other type, however in principle the magnetic material should remain wholly with the air gap when the coil is in its equilibrium position and should extend preferably along the complete axial length of the air gap.

CLAIMS

1. An electromechanical loudspeaker of the moving coil type including magnetic pole pieces defining an air gap within which the coil is at least partially located, the coil having in moving association with it, magnetisable material operative to interact with the magnetic field produced by the said pole pieces to damp movement of the coil, and wherein at equilibrium said magnetisable material is located wholly within the axial extent of said air gap and symmetrically with respect to the axial limits thereof, and the coil occupies substantially the full axial extent of the air gap.

2. A loudspeaker as claimed in claim 1 wherein the magnetisable material comprises plastics tape incorporating magnetic composition.

3. A loudspeaker as claimed in claim 2 wherein said coil comprises a coil of wire wound around a former and said magnetisable material is included as a layer between the coil and the former.

4. A loudspeaker substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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